

Past-paper walk-through

Alkenes ■ 11.5

eXercise

Questions in this set

- 0620/21 N25 Q36 ■ 1 mark
- 0620/22 N25 Q32 ■ 1 mark
- 0620/23 N25 Q17 ■ 1 mark
- 0620/23 N25 Q36 ■ 1 mark
- 0620/23 J25 Q33 ■ 1 mark
- 0620/42 J25 Q6 ■ 18 marks
- 0620/42 M25 Q6 ■ 14 marks

Reading the mark scheme

- **B1** a mark that stands on its own – the point is either made or not.
- **M1** a *method* mark: the right approach, even if the number is wrong.
- **A1** an *answer* mark, and it usually needs its M mark first.
- **C1** a working mark on the way to the answer.
- **//** separates answers the examiner accepts equally.
- **ecf** = error carried forward: a later part is marked on your own earlier answer.
- **owtte** = “or words to that effect” – the wording need not match.

Question 36

0620/21 N25 ■ Q36 ■ 1 mark

36 Ethene reacts with hydrogen in an addition reaction to form ethane.

Which catalyst is used for this reaction?

- A** iron
- B** nickel
- C** vanadium(V) oxide
- D** yeast

Solution 36

Answer: **B**

Why

- Hydrogenating an alkene uses a nickel catalyst.
- Iron is the Haber process catalyst and vanadium(V) oxide the Contact process one.
- Yeast is a biological catalyst for fermentation, not for hydrogenation.

Question 32

0620/22 N25 ■ Q32 ■ 1 mark

32 The alkenes are a homologous series.

Which statement about the members of the homologous series of the alkenes is correct?

- A** They have the same functional group.
- B** They have the same relative molecular mass.
- C** They have different chemical properties.
- D** They have different general formulae.

Solution 32

Answer: **A**

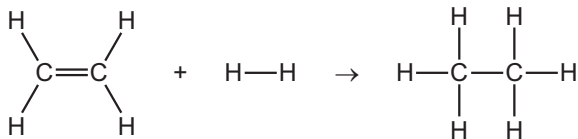
Why

- A homologous series shares the same functional group and the same general formula.
- For the alkenes the functional group is the $\text{C}=\text{C}$ double bond.
- Their relative molecular masses differ, and so do their physical properties – only the trend is shared.

Question 17

0620/23 N25 ■ Q17 ■ 1 mark

17 Ethene reacts with hydrogen to form ethane.



The bond energies are shown in the table.

bond	bond energy in kJ/mol
------	--------------------------

Question 17

C–C	+350
C–H	+410
H–H	+436
C=C	+614

What is the enthalpy change for the reaction?

A –290 kJ/mol

B –120 kJ/mol

Question 17

C +120 kJ/mol

D +290 kJ/mol

Solution 17

Answer: **B**

Why

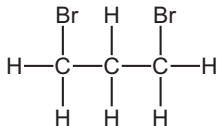
- Bonds broken: $\text{C}=\text{C} + 4(\text{C}-\text{H}) + \text{H}-\text{H} = 614 + 1640 + 436 = 2690 \text{ kJ}$.
- Bonds formed: $\text{C}-\text{C} + 6(\text{C}-\text{H}) = 350 + 2460 = 2810 \text{ kJ}$.
- $\Delta H = 2690 - 2810 = -120 \text{ kJ/mol}$.

Question 36

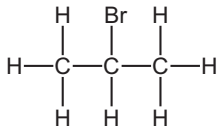
0620/23 N25 ■ Q36 ■ 1 mark

36 Propene undergoes addition reactions with bromine, hydrogen and steam.

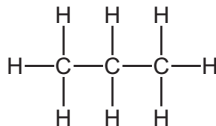
Which structures represent a product of these reactions?



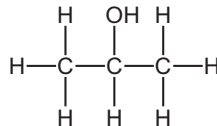
1



2



3



4

A 1 and 3**B** 1 and 4**C** 2 and 3**D** 3 and 4

Solution 36

Answer: **D**

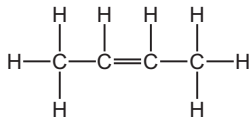
Why

- Bromine adds across the double bond, putting a bromine on *each* of the two carbons.
- Hydrogen adds to give propane, and steam adds to give propan-2-ol.
- So look for the dibromo product on adjacent carbons, not a single bromine atom.

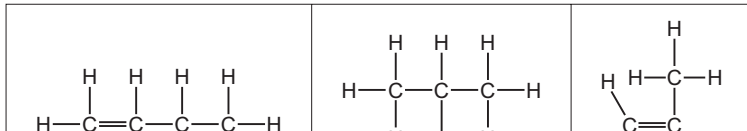
Question 33

0620/23 J25 ■ Q33 ■ 1 mark

33 The displayed formula of but-2-ene is shown.



Which displayed formulae represent structural isomers of but-2-ene?



Question 33

$\begin{array}{c} \quad \\ \text{H} \quad \text{H} \end{array}$	$\begin{array}{c} \text{H} \quad \quad \text{H} \\ \quad \quad \\ \text{H}-\text{C}-\text{H} \\ \\ \text{H} \end{array}$	$\begin{array}{c} \text{H} \quad \quad \text{H} \\ / \quad \quad \\ \text{H}-\text{C}-\text{H} \\ \\ \text{H} \end{array}$
1	2	3

- A** 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

Solution 33

Answer: **C**

Why

- But-2-ene is C_4H_8 , so an isomer must have exactly that formula.
- Both the position of the double bond and the branching of the chain can be changed.
- So look for the structures that are still C_4H_8 but with the atoms joined differently.

Question 6

0620/42 J25 ■ Q6 ■ 18 marks

- 6** Ethene, C_2H_4 , is the first member of a family of similar compounds which contains the alkene functional group.
- (a)** State the term for a family of similar compounds which contain the same functional group.

Question 6

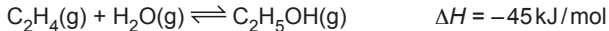
- (b) Determine the difference in relative molecular mass between C_2H_4 and the next member in this family of similar compounds.

Question 6

(c) Write the symbol equation for the complete combustion of C_2H_4 .

Question 6

- (d) C_2H_4 reacts with steam to form ethanol.



The process happens in a closed system and the reaction reaches an equilibrium.

The conditions for this process are 300°C and 60 atm pressure. H_3PO_4 is used as a catalyst.

- (i) Complete Table 6.1 to show the effect, if any, on the concentration of $\text{C}_2\text{H}_4(\text{g})$ when the following changes to the conditions are applied.

Only use the words **increases**, **decreases** or **no change**.

Table 6.1

Question 6

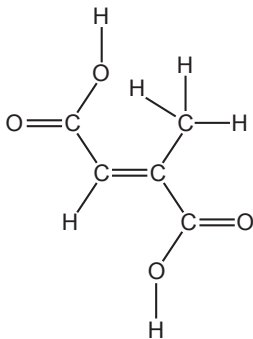
change to condition	effect on the concentration of $\text{C}_2\text{H}_4(\text{g})$ at equilibrium
temperature is decreased	
some $\text{C}_2\text{H}_5\text{OH}(\text{g})$ is removed	
pressure is increased	
a more effective catalyst is used	

[4]

- (ii) Explain, in terms of collision theory, why the rate of the forward reaction increases if the temperature increases.

Question 6

(e) Compound **B** has the displayed formula shown in Fig. 6.1.



Question 6

Fig. 6.1

- (i) Deduce the molecular formula of compound **B**.

Question 6

(ii) State why compound **B** is unsaturated.

Question 6

- (iii) Draw the structure of **one** repeat unit of the polymer formed when compound **B** undergoes addition polymerisation.

Question 6

[2]

- (iv) Explain why 1 mol of compound **B** reacts with 2 mol of sodium hydroxide, NaOH.

Question 6

- (v) Calculate the volume, in cm^3 , of 0.250 mol/dm^3 NaOH that reacts with 0.100 mol of compound **B**.

Question 6

IV	V	VI	VII	VIII
				2 He helium 4
6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
82 Pb lead 207	83 Bi bismuth 209	84 Po polonium —	85 At astatine —	86 Rn radon —
114 Fl flerovium —	115 Mc moscovium —	116 Lv livermorium —	117 Ts tennessine —	118 Og oganeson —

68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
100 Fm fermium —	101 Md mendelevium —	102 No nobelium —	103 Lr lawrencium —

[Total: 18]

Question 6

| | | | | , | | ge | | | ft | | , | ft |

Question 6

Periodic Table of Elements

Group									
								III	
I	II	III	IV	V	VI	VII	VIII	IX	X
1	2	3	4	5	6	7	8	9	10
Li	Be	B	C	N	O	F	Ne		
3	4	5	6	7	8	9	10	11	12
Na	Mg	Al	Si	P	S	Cl	Ar	K	Ca
13	14	15	16	17	18	19	20	21	22
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni
23	24	25	26	27	28	29	30	31	32
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd
33	34	35	36	37	38	39	40	41	42
Cs	Ba	La	Hf	Ta	W	Re	Os	Pt	Au
43	44	45	46	47	48	49	50	51	52
Fr	Ra	Ac	Th	Pa	U	Np	Pu	Am	Cm
53	54	55	56	57	58	59	60	61	62
At	Po	Bi	Po	At	Bi	Po	At	Bi	Po
81	82	83	84	85	86	87	88	89	90
Tl	Pb	Bi	Po	At	Bi	Po	At	Bi	Po
91	92	93	94	95	96	97	98	99	100
Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf
101	102	103	104	105	106	107	108	109	110
La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy
111	112	113	114	115	116	117	118	119	120
Rn	Fr	Ra	Ac	Th	Pa	U	Np	Pu	Am
121	122	123	124	125	126	127	128	129	130
Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu	Uu

nd pressure (r.t.p.).

Question 6

h | | | 1 f /dic 1 |

| 2l F lrc 5l | 4 R ther 10 | 7l O smi 19 | 10 H ass - |

| 6: Sl ma 15 | 9 P utor - | al

Question 6

T

--	--

Key

atomic number	atomic symbol
name	relative atomic mass

21	Sc	22	Ti	23	V	24	Cr	25	Mn
scandium	45	titanium	48	vanadium	51	chromium	52	manganese	55
39	Y	40	Zr	41	Nb	42	Mo	43	Tc
yttrium	89	zirconium	91	niobium	93	molybdenum	96	technetium	—
57–71	lanthanoids	72	Hf	73	Ta	74	W	75	Re
lanthanoids	—	hafnium	178	tantalum	181	tungsten	184	rhenium	186
89–103	actinoids	104	Rf	105	Db	106	Sg	107	Bh
actinoids	—	rutherfordium	—	dubnium	—	seaborgium	—	bohrium	—

57	La	139	lanthanum	58	Ce	140	cerium	59	Pr	141	praseodymium	60	Nd	144	neodymium	61	Pm	—	promethium
89	Ac	—	actinium	90	Th	232	thorium	91	Pa	231	protactinium	92	U	238	uranium	93	Np	—	neptunium

if one mole of any gas is 24 dm³ at room temperature

Question 6

I	II

3 Li lithium 7	4 Be beryllium 9
11 Na sodium 23	12 Mg magnesium 24
19 K potassium 39	20 Ca calcium 40
37 Rb rubidium 85	38 Sr strontium 88
55 Cs caesium 133	56 Ba barium 137
87 Fr francium —	88 Ra radium —

alkali metals

halogens

The noble gases

Solution 6

(a)

Mark scheme

- homologous series
- 1

Solution 6

(b)

Mark scheme

- 14
- 1

Solution 6

(c)

Mark scheme

- $\text{C}_2\text{H}_4 + 3\text{O}_2 \rightarrow 2\text{CO}_2 + 2\text{H}_2\text{O}$ (M1)
- $\text{CO}_2 + \text{H}_2\text{O}$ (M2)
- correct equation
- 2

Solution 6

(d)(i)

Mark scheme

- M1 decreases (M2)
- decreases (M3)
- decreases (M4)
- no change
- 4

Solution 6

(d)(ii)

Mark scheme

- M1 kinetic energy of particles increases (M2)
- frequency of collisions between particles increases (M3)
- higher percentage / proportion / fraction of collisions / particles have energy greater than / equal to activation energy
- 3

Solution 6

(e)(i)

Mark scheme

- C₅H₆O₄
- 1

(e)(ii)

Mark scheme

- it has a carbon-carbon bond which is not a single bond
- 1

Solution 6

(e)(iii)

Mark scheme

- M1 one C – C single bond with continuation bonds **M2**
- correct structure
- 2

Solution 6

(e)(iv)

Mark scheme

- compound B has two carboxylic acid groups
- 1

Solution 6

(e)(v)

Mark scheme

- M1 (mol of NaOH reacting) = 0.2(00) M2
- volume = $1000 \times 0.2(00) / 0.250 = 800 \text{ cm}^3$
- 2

Question 6

0620/42 M25 ■ Q6 ■ 14 marks

6 The structural formulae of two compounds, **A** and **B**, are shown.

A	B
$\text{CH}_2=\text{CHCH}_3$	$\text{CH}_3\text{CH}=\text{CHCH}_3$

A and **B** are members of the same homologous series.

(a) Give **two** reasons why the structural formulae of **A** and **B** show they are members of the same homologous series.

Question 6

Question 6

[2]

(b) Explain why **A** and **B** are both hydrocarbons.

Question 6

(c) Write the symbol equation for the complete combustion of **A**.

Question 6

(d) Deduce the empirical formula of **A**.

Question 6

(e) Name compound **B**.

Question 6

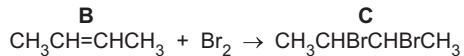
- (f) A structural isomer of **B** is a member of the same homologous series.

Draw the displayed formula of this structural isomer of **B**.

Question 6

[1]

- (g) Compound **B** reacts with aqueous bromine at room temperature to form product **C**.
The equation is shown.



- (i) State why this is an addition reaction.

Question 6

- (ii) Describe the colour change in aqueous bromine during this reaction.

Question 6

(iii) Name product **C**.

Question 6

- (h) Under certain conditions, **one** mole of **B** reacts with oxygen to form **two** moles of carboxylic acid **D**.

Carboxylic acid **D** has **two** carbon atoms.

- (i) Draw the displayed formula of carboxylic acid **D**.

Question 6

[1]

(ii) Name carboxylic acid **D**.

Question 6

(iii) Complete the symbol equation for this reaction.

Question 6

IV	V	VI	VII	VIII
				2 He helium 4
6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
82 Pb lead 207	83 Bi bismuth 209	84 Po polonium —	85 At astatine —	86 Rn radon —
114 Fl flerovium —	115 Mc moscovium —	116 Lv livermorium —	117 Ts tennessine —	118 Og oganeson —

68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
100 Fm fermium —	101 Md mandeleevium —	102 No nobelium —	103 Lr lawrencium —

[1]

[Total: 14]

Question 6

| | | | | | | 9 | | | | | | | |

Question 6

The Periodic Table of Elements

Group									
1									III
H hydrogen 1									
26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70				
44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115				
76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204				
108 Hs hassium —	109 Mt meitnerium —	110 Ds darmstadtium —	111 Rg roentgenium —	112 Cn copernicium —	113 Nh nihonium —				
62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165				
94 Pu plutonium —	95 Am americium —	96 Cm curium —	97 Bk berkelium —	98 Cf californium —	99 Es einsteinium —				

re and pressure (r.t.p.).

Question 6

| | ———

—————|—————|—————|—————|

—————|—————| 5

Question 6

II	

Key

	atomic number atomic symbol name relative atomic mass					
4 Be beryllium 9						
12 Mg magnesium 24						
20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	
38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	
56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	
88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	

oids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –
s	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –

ume of one mole of any gas is 24 dm³ at room temperat

Question 6

Question 6

—
—
—
I
—

3	Li	lithium	7
11	Na	sodium	23
19	K	potassium	39
37	Rb	rubidium	85
55	Cs	caesium	133
87	Fr	francium	—

lantha

actinoi

The vc

Solution 6

(a)

Mark scheme

- M1 (have a) general formula of C_nH_{2n} M2
- (have a) $C=C$ functional group
- 2

Solution 6

(b)

Mark scheme

- compounds made of C and H only
- 1

Solution 6

(c)

Mark scheme

- $2\text{C}_3\text{H}_6 + 9\text{O}_2 \rightarrow 6\text{CO}_2 + 6\text{H}_2\text{O}$ (M1)
- $\text{CO}_2 + \text{H}_2\text{O}$ as only products (M2)
- correct equation
- 2

Solution 6

(d)

Mark scheme

- CH₂
- 1

Solution 6

(e)

Mark scheme

- but-2-ene
- 1

Solution 6

(f)

Mark scheme

- displayed formula of but-1-ene
- 1

Solution 6

(g)(i)

Mark scheme

- only one product is formed
- 1

(g)(ii)

Mark scheme

- orange to colourless
- 1

Solution 6

(g)(iii)

Mark scheme

- 2,3-dibromobutane
- 1

Solution 6

(h)(i)

Mark scheme

- displayed formula of ethanoic acid
- 1
- 0620/42
- February/March 2025

Solution 6

(h)(ii)

Mark scheme

- ethanoic acid
- 1

(h)(iii)

Mark scheme

- $\text{CH}_3\text{CH}=\text{CHCH}_3 + 2\text{O}_2 \rightarrow 2\text{CH}_3\text{COOH}$
- 1